20030 E6h56660

FIG. 1
(PRIOR ART)

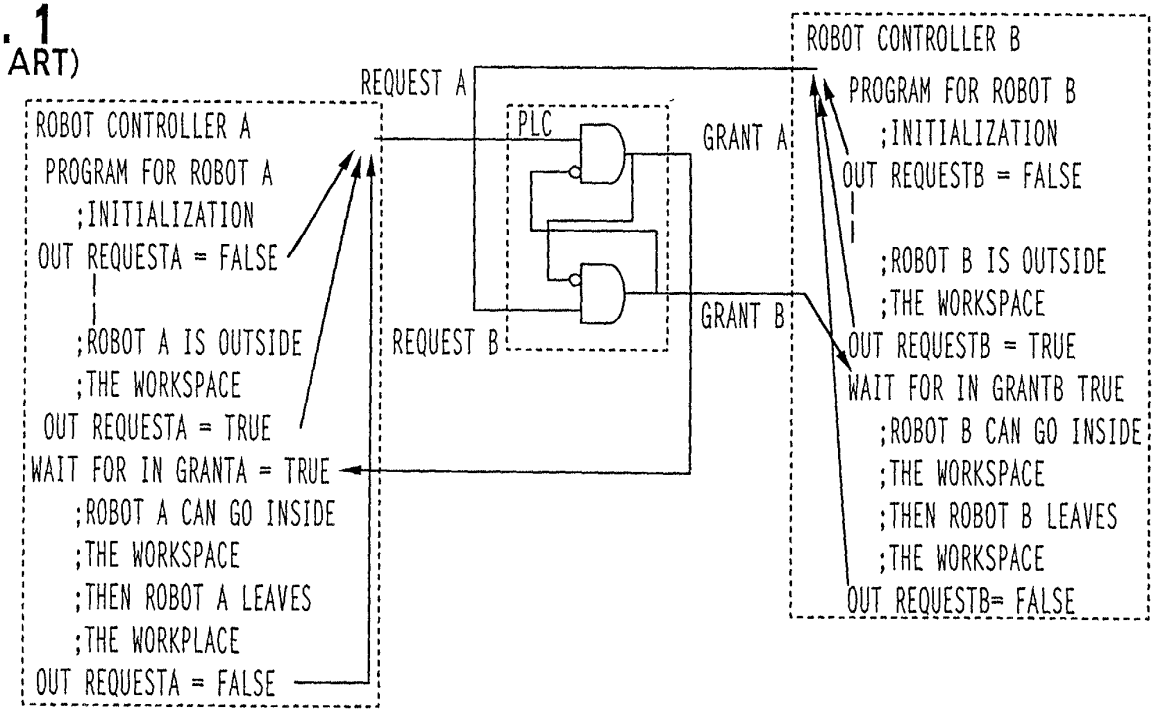

FIG. 4

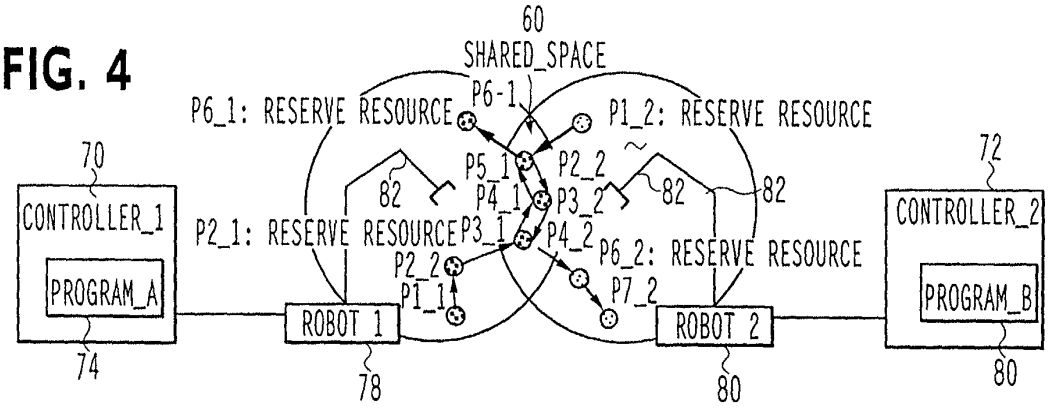

FIG. 2

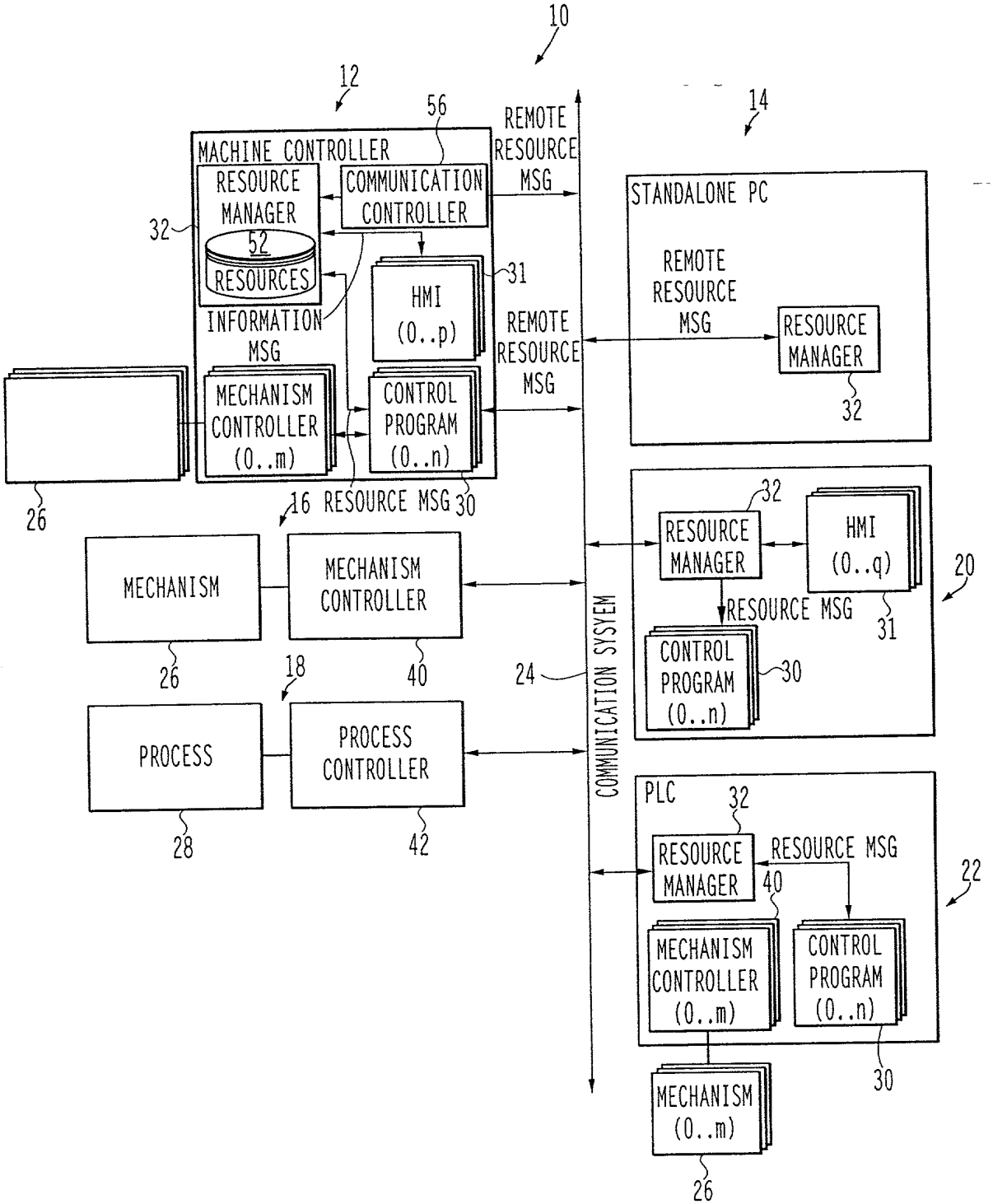
10
12
14
56
MACHINE CONTROLLER
RESOURCE MANAGER
COMMUNICATION CONTROLLER
REMOTE RESOURCE MSG
32
52
RESOURCES
INFORMATION MSG
HMI (0..p)
31
MECHANISM CONTROLLER (0..m)
CONTROL PROGRAM (0..n)
REMOTE RESOURCE MSG
STANDALONE PC
REMOTE RESOURCE MSG
RESOURCE MANAGER
32
26
16
RESOURCE MSG
30
MECHANISM
MECHANISM CONTROLLER
26
40
18
24
COMMUNICATION SYSYEM
PROCESS
PROCESS CONTROLLER
28
42
RESOURCE MANAGER
32
HMI (0..q)
20
RESOURCE MSG
31
CONTROL PROGRAM (0..n)
30
PLC
32
RESOURCE MANAGER
RESOURCE MSG
40
22
MECHANISM CONTROLLER (0..m)
CONTROL PROGRAM (0..n)
30
MECHANISM (0..m)
26

FIG. 3

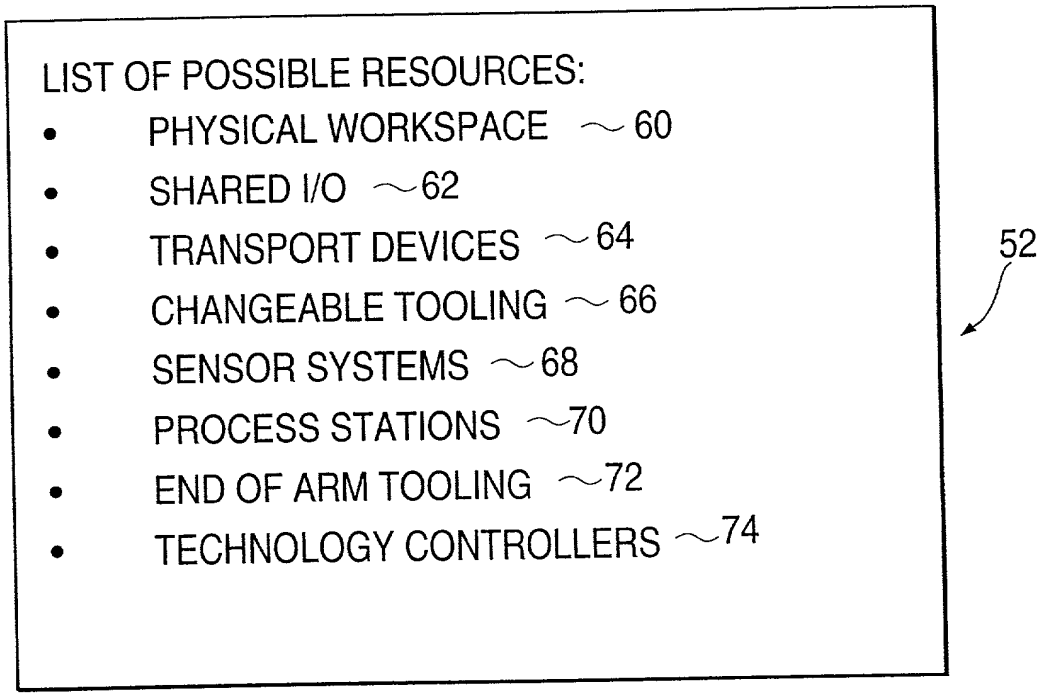
LIST OF POSSIBLE RESOURCES:
• PHYSICAL WORKSPACE ~60
• SHARED I/O ~62
• TRANSPORT DEVICES ~64
• CHANGEABLE TOOLING ~66
• SENSOR SYSTEMS ~68
• PROCESS STATIONS ~70
• END OF ARM TOOLING ~72
• TECHNOLOGY CONTROLLERS ~74
52

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FIG. 5

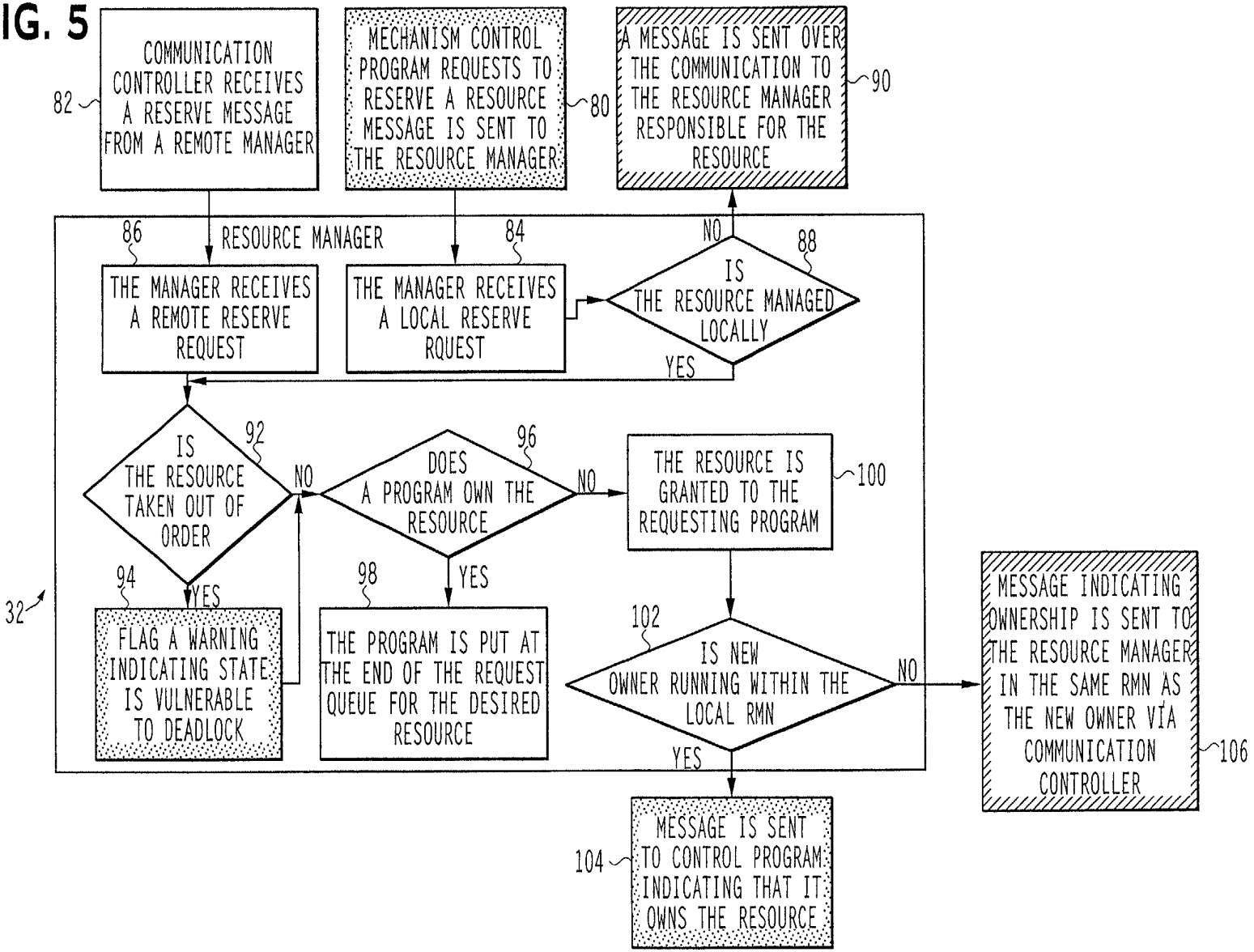


FIG. 6

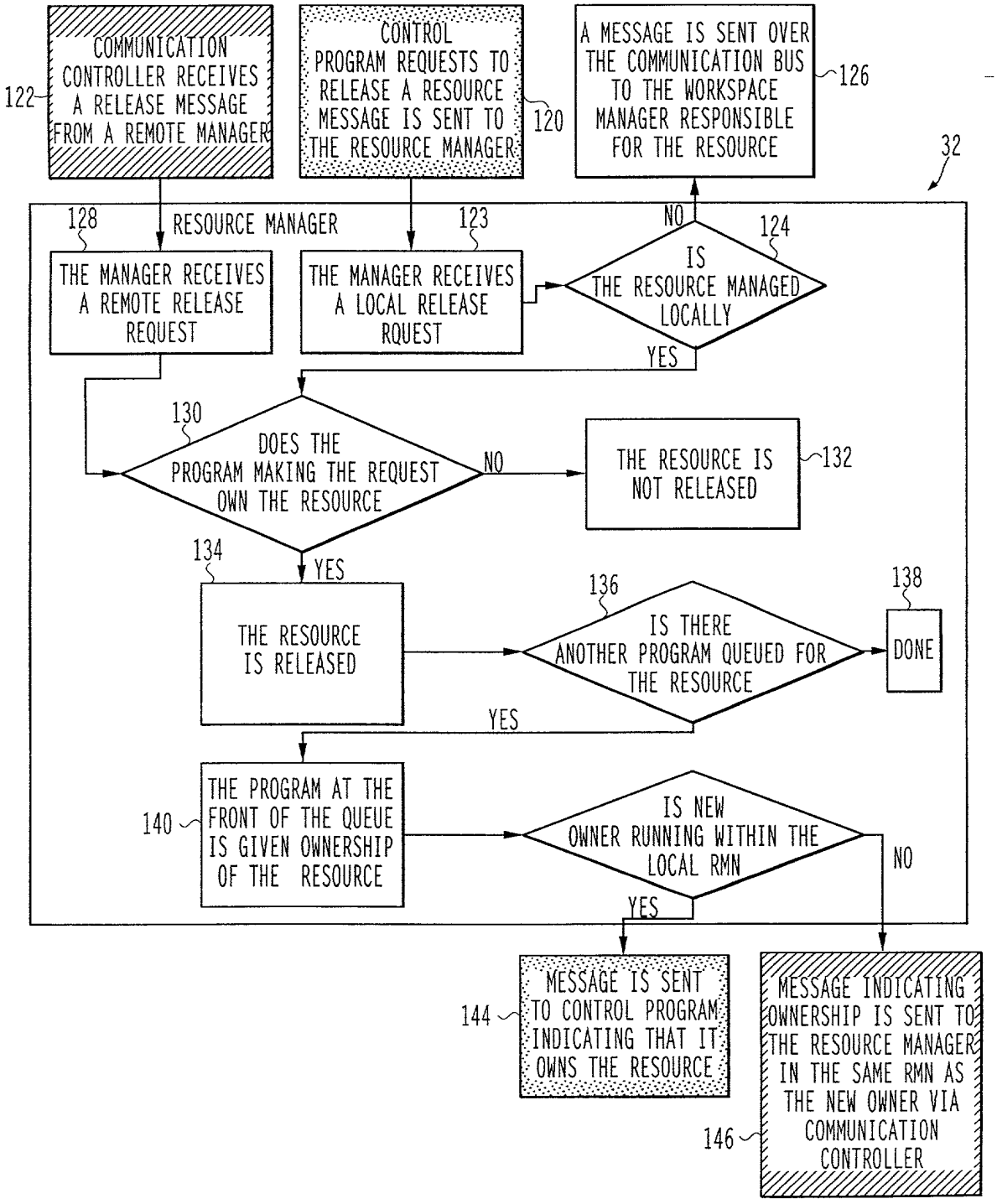
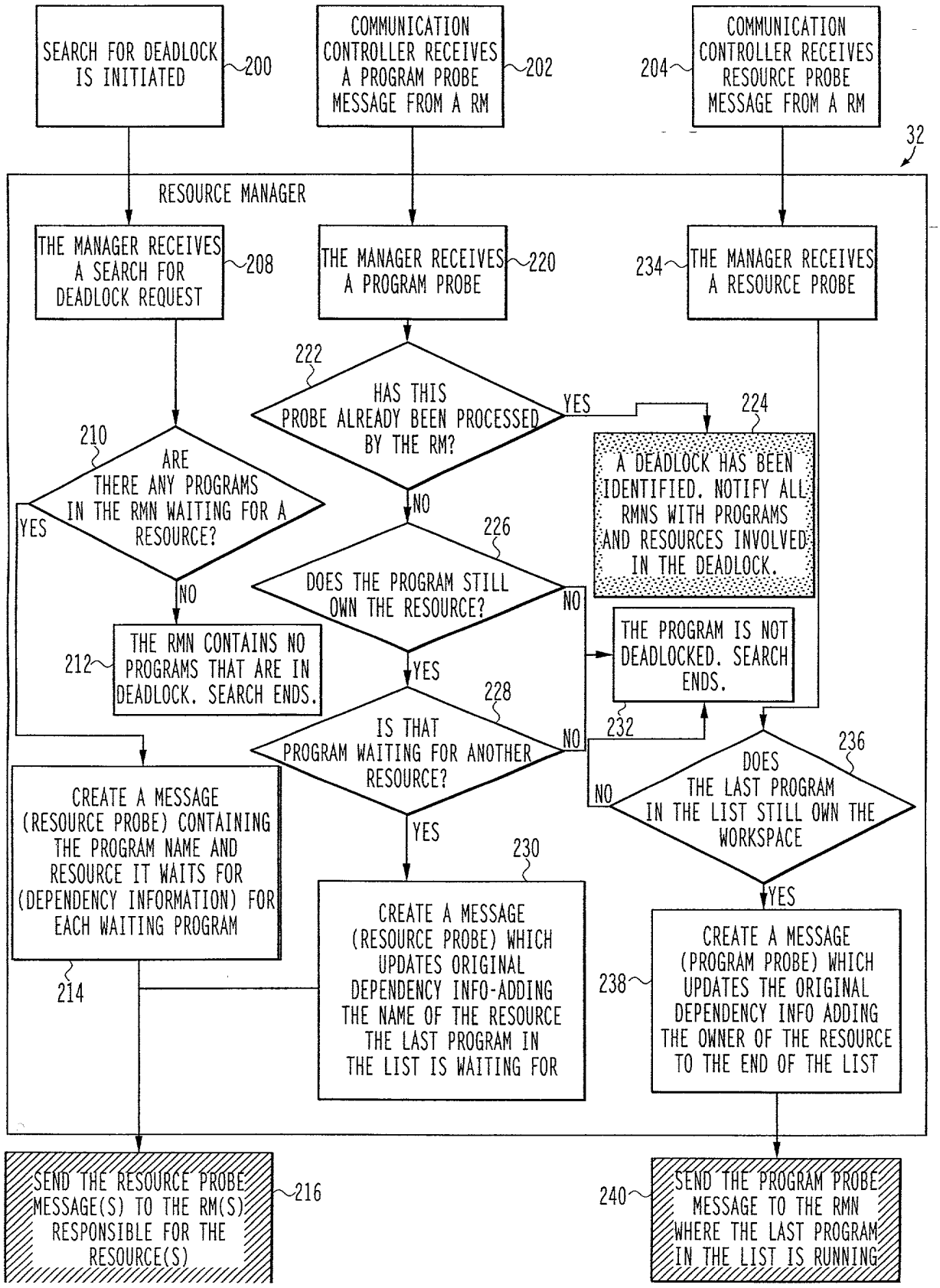

COMMUNICATION CONTROLLER RECEIVES A RELEASE MESSAGE FROM A REMOTE MANAGER
122
CONTROL PROGRAM REQUESTS TO RELEASE A RESOURCE MESSAGE IS SENT TO THE RESOURCE MANAGER
120
A MESSAGE IS SENT OVER THE COMMUNICATION BUS TO THE WORKSPACE MANAGER RESPONSIBLE FOR THE RESOURCE
126
32
RESOURCE MANAGER
128
THE MANAGER RECEIVES A REMOTE RELEASE REQUEST
123
THE MANAGER RECEIVES A LOCAL RELEASE RQUEST
NO
124
IS THE RESOURCE MANAGED LOCALLY
YES
130
DOES THE PROGRAM MAKING THE REQUEST OWN THE RESOURCE
NO
THE RESOURCE IS NOT RELEASED
132
134
YES
THE RESOURCE IS RELEASED
136
IS THERE ANOTHER PROGRAM QUEUED FOR THE RESOURCE
138
DONE
YES
140
THE PROGRAM AT THE FRONT OF THE QUEUE IS GIVEN OWNERSHIP OF THE RESOURCE
IS NEW OWNER RUNNING WITHIN THE LOCAL RMN
NO
YES
144
MESSAGE IS SENT TO CONTROL PROGRAM INDICATING THAT IT OWNS THE RESOURCE
146
MESSAGE INDICATING OWNERSHIP IS SENT TO THE RESOURCE MANAGER IN THE SAME RMN AS THE NEW OWNER VIA COMMUNICATION CONTROLLER

FIG. 7


SEARCH FOR DEADLOCK IS INITIATED
200
COMMUNICATION CONTROLLER RECEIVES A PROGRAM PROBE MESSAGE FROM A RM
202
204
COMMUNICATION CONTROLLER RECEIVES RESOURCE PROBE MESSAGE FROM A RM
32
RESOURCE MANAGER
THE MANAGER RECEIVES A SEARCH FOR DEADLOCK REQUEST
208
THE MANAGER RECEIVES A PROGRAM PROBE
220
234
THE MANAGER RECEIVES A RESOURCE PROBE
222
HAS THIS PROBE ALREADY BEEN PROCESSED BY THE RM?
YES
224
A DEADLOCK HAS BEEN IDENTIFIED. NOTIFY ALL RMNS WITH PROGRAMS AND RESOURCES INVOLVED IN THE DEADLOCK.
NO
210
ARE THERE ANY PROGRAMS IN THE RMN WAITING FOR A RESOURCE?
YES
NO
226
DOES THE PROGRAM STILL OWN THE RESOURCE?
NO
YES
THE PROGRAM IS NOT DEADLOCKED. SEARCH ENDS.
232
212
THE RMN CONTAINS NO PROGRAMS THAT ARE IN DEADLOCK. SEARCH ENDS.
228
IS THAT PROGRAM WAITING FOR ANOTHER RESOURCE?
NO
YES
236
DOES THE LAST PROGRAM IN THE LIST STILL OWN THE WORKSPACE
NO
YES
CREATE A MESSAGE (RESOURCE PROBE) CONTAINING THE PROGRAM NAME AND RESOURCE IT WAITS FOR (DEPENDENCY INFORMATION) FOR EACH WAITING PROGRAM
214
230
CREATE A MESSAGE (RESOURCE PROBE) WHICH UPDATES ORIGINAL DEPENDENCY INFO-ADDING THE NAME OF THE RESOURCE THE LAST PROGRAM IN THE LIST IS WAITING FOR
238
CREATE A MESSAGE (PROGRAM PROBE) WHICH UPDATES THE ORIGINAL DEPENDENCY INFO ADDING THE OWNER OF THE RESOURCE TO THE END OF THE LIST
SEND THE RESOURCE PROBE MESSAGE(S) TO THE RM(S) RESPONSIBLE FOR THE RESOURCE(S)
216
240
SEND THE PROGRAM PROBE MESSAGE TO THE RMN WHERE THE LAST PROGRAM IN THE LIST IS RUNNING